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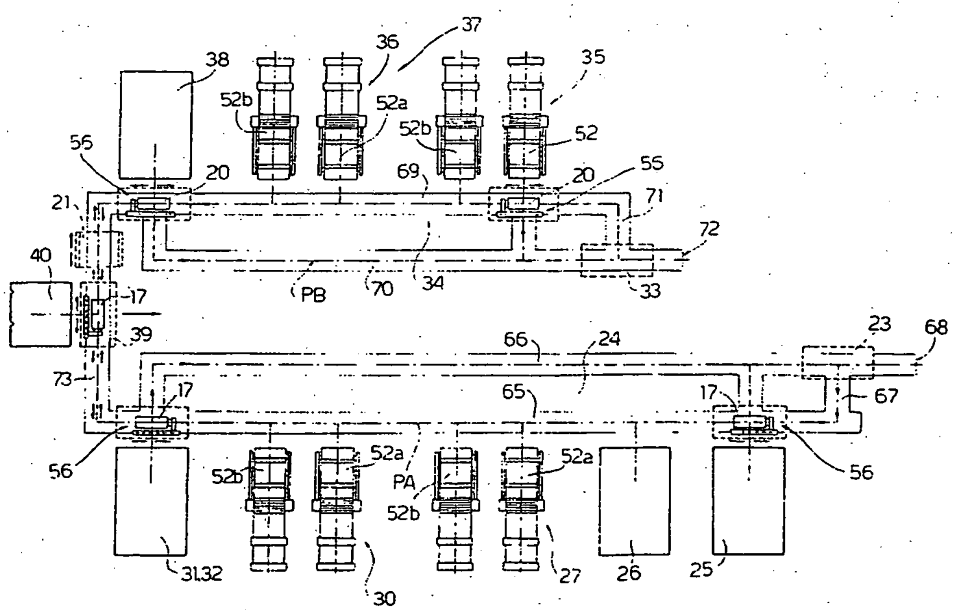
(54) Title: TIRE MANUFACTURING METHOD



(57) Abstract: A method of manufacturing tires (1) defined by a number of components (3-16), and wherein at least one mobile tire building unit (56) is moved along a feedpath (PA, PB) extending through a number of work stations (25-32, 35-40) to receive at least one of the work stations (25-32, 35-40) being a programmable work station, wherein the relative component is formed directly on the mobile unit (56) by depositing, on the mobile unit (56), a stip (45) of elastomeric material, which is deposited along a given programmable deposition path (P1; P2; P3).

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TIRE MANUFACTURING METHOD

TECHNICAL FIELD

The present invention relates to a tire manufacturing method.

More specifically, the present invention relates to a tire manufacturing method of the type comprising the steps of forming a flat, substantially cylindrical inner radial carcass by assembling a number of first components; shaping said inner radial carcass into a toroidal shape; and feeding onto said radial carcass an annular outer carcass formed by assembling a number of second components; said components being assembled on at least one building unit, which is moved along a given feed path (PA; PB) extending through a number of work stations (25-32, 35-40), at each of which at least one said component is fed onto said building unit.

BACKGROUND ART

In the tire industry, the manufacturing method still most commonly used is the traditional one, whereby said tire components are produced beforehand and stored, and are fed successively to a manufacturing machine normally

comprising a fixed building unit normally defined by a building drum, which, on modern manufacturing machines, is normally a unistage drum, and a number of feed conveyors, the outputs of which are arranged radially with respect to the building drum, and are superimposed to feed the components successively onto the building drum.

The traditional method described above - which calls for a lot of component storage space, a large work force for moving the components in and out of the store, relatively high-cost manufacturing machines which are not always easy to service, and a good deal of relatively time-consuming work to make any structural and/or size changes - is only feasible when producing a relatively large number of tires of the same type and size, and is totally unsuitable when a certain degree of flexibility in production is required.

To eliminate component prefabrication and storage, so-called JIT (Just In Time) tire manufacturing methods have been proposed, whereby the manufacturing machine referred to above is associated with a given number of extruders for producing some or all of the components directly on the spot as they are needed. And, to reduce the number of feed conveyors required, multiple extruders have been proposed for producing and preassembling a number of components, which are then fed to the building drum by a single feed conveyor.

JIT methods indeed provide for considerable saving

at plant level, by substantially eliminating storage and handling costs and rejects caused by stock aging. On the other hand, they call for special extruders, which are relatively expensive and extremely difficult to adapt to different sizes.

In other words, JIT methods have proved feasible only as regards space, labour and reject saving, and when used in sections producing one type of tire and possibly acting as end stations of respective vehicle assembly lines, and are totally unsuitable when any degree of flexibility in production is required.

So-called MD (Mobile Drum) and MMD (Multi Mobile Drum) methods, on the other hand, are substantially designed to increase production flexibility, at least as regards structural changes, and at the same time simplify the manufacturing machines, and employ at least one mobile building unit normally comprising a building drum movable along a succession of work stations, each for feeding a respective component onto the building drum. In advanced MD or MMD methods, the work stations are arranged along a production line, and comprise main stations arranged along a rail and each movable along the rail between a respective work position and a respective rest position; and secondary or accessory stations, which are arranged combfashion with respect to the rail, and can be moved along the rail in place of a main station once the main station is moved into the rest position.

At the end of the production line, and providing

only one size is involved, it is therefore possible to obtain a succession of tires of the same size and with, at most, different structural characteristics.

While simplifying the manufacturing machine, the component feed devices of which are distributed between various work stations, as opposed to being grouped at one station, MD and MMD methods nevertheless normally fail to eliminate the problems posed by component prefabrication, storage and handling, and fail to simplify size changes, which can only be made by stopping the manufacturing machine for relatively prolonged periods, and adjusting the geometric configuration of a relatively large number of mechanical components.

DISCLOSURE OF THE INVENTION

It is an object of the present invention to provide an improved MD or MMD method - i.e. a method comprising forming an initially substantially cylindrical and subsequently toroidal-shaped carcass on at least one mobile building unit - which provides for reducing storage and handling problems, and for increasing production flexibility by simplifying, in particular, size changes.

According to the present invention, there is provided a tire manufacturing method as claimed in Claim 1 and, preferably, in any one of the following Claims.

BRIEF DESCRIPTION OF THE DRAWINGS

A number of non-limiting embodiments of the present invention will be described by way of example with

reference to the accompanying drawings, in which:

Figure 1 shows a partly sectioned view in perspective of a tire formed in accordance with the method of the present invention;

Figure 2 shows, schematically and in section, an exploded spread-out view of the Figure 1 tire as built on a building drum;

Figure 3 shows a schematic block diagram of a system implementing the method of the present invention;

Figure 4 shows a schematic view, with parts removed for clarity, of a detail in Figure 3;

Figure 5 shows, schematically, a first operating mode of the Figure 4 detail;

Figure 6 shows, schematically, a second operating mode of the Figure 4 detail;

Figure 7 shows, schematically, a third operating mode of the Figure 4 detail;

Figure 8 shows schematically, and partly in block form, a preferred embodiment of the Figure 3 system;

Figure 9 shows a schematic side view of a detail in Figure 8;

Figure 10 shows schematically, and partly in block form, a variation of the Figure 8 system;

Figure 11 shows a schematic view in perspective of a detail in Figure 10 and a further operating mode of the Figure 4 detail.

BEST MODE FOR CARRYING OUT THE INVENTION

Number 1 in Figure 1 indicates as a whole a known

road-vehicle tire having a substantially standard structure, and comprising an inner radial carcass 2 defined by a number of components comprising two metal bead bundles 3 with respective annular bead fillers 4, and at least one body ply 5 reinforced internally with synthetic or metal wires, and normally comprising two lateral portions 6, each turned up about a respective bead bundle 3. Said components also comprise a layer 7, which is impermeable to air, covers the inner surface of body ply 5 between the two bead bundles 3, and is defined by two superimposed layers, the outer one of which, indicated 8, is a butyl innerliner, and the other of which, indicated 9 and located between butyl innerliner 8 and body ply 5, is an insulating innerliner. Said components also comprise an annular abrasion strip 10 and an annular sidewall 11, both located outwards of each bead bundle 3. Tire 1 also comprises an outer carcass 2' defined by further components, such as a tread belt 12 located outwards of body ply 5, between the two sidewalls 11, and normally defined by two superimposed tread plies 13 and 14 and a superimposed treated axial cloth ply 16, i.e. a rubber-coated cloth ply with reinforcing wires perpendicular to the wires of body ply 5; and a tread 15 on an outer surface of tread belt 12.

As shown in Figure 2, the known tire 1 described above is normally formed on a unistage building drum 17 comprising two coaxial half-drums 18 movable with respect to each other along an axis 19 between a parted rest

position shown in Figure 2, and a closed shaping position (not shown).

Tire 1 is formed normally on building drum 17 in known manner according to a sequence which comprises placing on each half-drum 18 a relative sidewall 11 and a relative abrasion strip 10 overlapping and projecting partly from relative sidewall 11 towards the other sidewall 11. Building drum 17 is then fed firstly with impermeable layer 7, the opposite edges of which are superimposed on at least the portions of relative abrasion strips 10 projecting from relative sidewalls 11, and the butyl innerliner 8 of which is positioned contacting abrasion strips 10; and secondly with body ply 5, which is normally wide enough to entirely cover impermeable layer 7 and abrasion strips 10. At this point, each half-drum 18 is fitted with a respective bead bundle 3 having a respective annular bead filler 4 and located outwards of body ply 5, substantially at the inner end of relative abrasion strip 10 and coaxial with axis 19; and each bead bundle 3 is clamped in position by expanding a known clamping ring (not shown) carried by relative half-drum 18.

The above operations form on building drum 17 a flat, i.e. as yet unshaped, inner radial carcass 2a, simultaneously with which, tread belt 12 is formed on a known collapsible auxiliary drum 20 (Figure 3) by feeding tread plies 13 and 14 successively and one on top of the other onto auxiliary drum 20, and by covering the tread

ply pack 13, 14 so formed with relative reinforced axial cloth ply 16.

Tread belt 12 is normally engaged on the outside by a known expansible carrier ring 21 (shown in Figure 3) and transferred, after first collapsing auxiliary drum 20, onto building drum 17, onto the outside of carcass 2a and coaxial with axis 19; and, by inflating known bladders (not shown) carried by each half-drum 18, all the parts of flat carcass 2a outwards of bead bundles 3 are normally turned up, and carcass 2a is shaped by bringing half-drums 18 together along axis 19, so that the central portion of body ply 5 is pressed against the inner surface of tread belt 12, which at this point can be released in position by carrier ring 21.

At this point, tire 1 and relative outer carcass 2' are completed by feeding tread 15 onto the outer surface of tread belt 12, and the finished tire 1 can be unloaded off building drum 17 and sent for curing.

The above operations can be performed by a tire manufacturing system of the type shown in Figure 3, in which a normally unistage building drum 17, once fitted at a tooling station 23 with half-drums 18 of the right size for the tires being produced, is fed along a main production line 24 comprising a succession of work stations, at which building drum 17 receives the above components to form a relative flat carcass 2a. More specifically, building drum 17 receives sidewalls 11 at a first work station 25; abrasion strips 10 at a second

work station 26; impermeable layer 7 at a third work station 27 comprising two substations 28 and 29 for supplying butyl innerliner 8 and insulating innerliner 9 respectively; body ply 5 at a fourth work station 30; and bead bundles 3 and relative annular bead fillers 4, for completing flat carcass 2a, at two further work stations 31 and 32.

At the same time building drum 17 is being fed through stations 24-32, an auxiliary drum 20, once equipped at a tooling station 33 to produce the required tires, is fed along a secondary production line 34 also comprising a succession of work stations, at which auxiliary drum 20 receives the components for forming a relative tread belt 12. More specifically, auxiliary drum 20 receives tread plies 13 and 14 at two substations 35 and 36 of a work station 37; and reinforced axial cloth ply 16, to complete tread belt 12, at a further work station 38.

At this point, building drum 17 is transferred to an assembly and unloading station 39, where the flat carcass 2a is shaped and simultaneously receives tread belt 12 removed off auxiliary drum 20 by carrier ring 21, and then tread 15 from a further work station 40.

In a variation not shown, in the event building drum 17 is a first-stage as opposed to a unistage drum, assembly and unloading station 39 comprises, in known manner, a second-stage drum (not shown), onto which flat carcass 2a is transferred by a known carrier ring (not

shown), and tread belt 12 is transferred by carrier ring 21.

In a further variation not shown, auxiliary drum 20, carrier ring 21, tooling station 33, and assembly station 39 are dispensed with, and tread belt 12 is assembled directly onto the shaped inner carcass 2.

In the Figure 3 system, many of the work stations described each feature at least one forming machine 41 as shown in Figure 4 and of the type described in Patent US-4,565 514, to which full reference is made herein for the sake of clarity.

Forming machine 41 comprises an extruder 42 for producing a continuous, normally circular-section extrusion 43 of crude elastomeric material, which is guided between two forming rollers 44a and 44b for converting the continuous extrusion 43 into a strip 45 of given section. In the example shown, said section is a half-oval. By varying the shape of the outer surfaces of forming rollers 44a and 44b, however, a strip 45 of any section may obviously be formed depending on the desired component. Strip 45 is fed to an applicator roller 46, which rotates continuously about an axis of rotation, and is supported in known manner (not shown) to move in three perpendicular directions, and to swivel about a further two axes perpendicular to each other and to the axis of rotation of applicator roller 46, under the control of an externally controlled logic unit 47.

Upstream from forming rollers 44a and 44b, extrusion

43 may be combined with reinforcing wires 48, which are unwound off respective reels 48a and fed between forming rollers 44a and 44b to produce an internally reinforced strip 45.

In actual use, forming machine 41 is used in combination with a mobile support, e.g. building drum 17 rotating about its axis 19, and under the control of logic unit 47, which combines the movement of the mobile support with the movements of applicator roller 46 according to programs relative to given mathematical models, so as to deposit strip 45 onto the mobile support along given paths and in one or more layers, and so form a continuous, variously shaped and sized tubular layer on the mobile support.

For example, as shown in Figure 5, using a forming machine 41, strip 45 can easily be deposited on each half-drum 18 along a substantially helical path P1, in particular, a substantially cylindrical coil, to obtain a continuous tubular component, which may be, for example, an abrasion strip 10, or an annular bead filler 4, or a sidewall 11, or, as shown in Figure 11, tread 15.

By depositing strip 45 along a multilayer path (not shown), in which each layer need not necessarily be the same shape and length as the adjacent layer underneath, the desired component can be "sculptured" as required. For example, all the components that are turned up when shaping relative tire 1 may be made of varying thicknesses to allow for localized stretch produced by

the turn-up operation.

Moreover, to obtain an abrasion strip 10 using rubber with a Shore hardness (after curing) of roughly 75-85, abrasion strip 10 may be so shaped as to incorporate relative annular bead filler 4 and eliminate work station 32.

In the event building drum 17 is a known type (not shown) with a telescopic intermediate support (in a fixed position between half-drums 18) capable of filling the gap of varying width between the half-drums 18 at all times, two different strips 45 may be deposited on building drum 17 by respective forming machines 41 to obtain a continuous tubular butyl innerliner 8 and a continuous tubular insulating innerliner 9.

As shown in Figure 6, by depositing an internally reinforced strip 45 along a generally sinusoidal path P2, a body ply 5 of desired width can be formed on building drum 17. It should be pointed out that, using a forming machine 41, body ply 5 may be formed directly on building drum 17, or (in an embodiment not shown) indirectly, i.e. formed on a flat surface during downtime of the system, and then fed to building drum 17 by a normal belt conveyor.

Finally, as shown in Figure 7, tread plies 13 and 14 can also be formed using a forming machine 41, by feeding a strip 45, reinforced internally with axial reinforcing wires 48, onto a tubular support 49 and along a helical path P1 with turns inclined with respect to the axis 50

of tubular support 49 by an angle equal to the wire slope angle of the desired tread plies 13 and 14. By making a number of successive passes of forming machine 41 to cover the whole of tubular support 49, a reinforced tubular body 51 is thus formed on tubular support 49, and which is cut along two substantially diametrically opposite generating lines to obtain the two tread plies 13 and 14, which are superimposed and then fed to building drum 17 by a normal belt conveyor 52.

In connection with the above, it should be pointed out that the above method of forming tread plies 13 an 14 may also be applied to body ply 5, which is obtained by forming, this time in a single pass and with as little inclination as possible, a reinforced tube (not shown), which is then cut along a single generating line.

If at least one of work stations 25, 26, 40 features one or more forming machines 41, at least one of the other work stations may be a conventional work station for receiving a relative prefabricated component and feeding it to building drum 17 on a normal belt conveyor 52. In which case, the conventional work station (in the example shown, work stations 27, 30 and 37) normally comprises a known interoperational store 53 (i.e. a compartment store, in which each component occupies a given space defined by coordinates known by a logic unit) in which a number of sizes of the same component can be stored in given locations; and a known transfer device 54 for selectively withdrawing a component of a given size

from relative interoperational store 53, and feeding it onto relative belt conveyor 52.

As shown in Figure 3, forming machines 41 and transfer devices 54 are controlled by a user-interface logic unit 55, which memorizes the distribution of the various prefabricated component sizes in relative interoperational stores 53, knows the various programs of logic units 47, and provides for loading a first number of data items 55a (inside radius, sidewall height, tread width, etc.) relative to the size of tire 1 to be produced, and a second number of data items 55b relative to the tire model to be produced, so that, without intervening directly on the system, production of a given tire can be set by the user fairly quickly, by simply using logic unit 55 to guide transfer devices 54 to withdraw the right components from relative interoperational stores 53, and to activate the right deposition program on each forming machine 41 by means of logic units 47.

In connection with the above, it should be pointed out that, using extruders 42 all producing the same extrusion 43, the forming machines 41 employed are substantially identical, except for forming rollers 44, which may differ from one machine to another. Using forming machines 41 therefore provides for substantial scale economy, for greatly simplifying maintenance as a whole, and for greatly reducing spare part storage.

The system shown in Figure 8 constitutes a

particular embodiment of, and comprises all the work stations in, the Figure 3 system. More specifically, in the Figure 8 system, work stations 25, 26 and 40 each comprise at least one respective forming machine 41, while the others are conventional work stations for each supplying a relative prefabricated component withdrawn by a respective transfer device 54 (not shown in Figure 8 for the sake of simplicity) from a respective interoperational store 53 (also not shown in Figure 8 for the sake of simplicity).

The Figure 8 system employs at least two building drums 17 along main line 24, and a corresponding number of auxiliary drums 20 along secondary line 34; and each of drums 17 and 20 forms part of a respective mobile building unit 56 shown in detail in Figure 9 and comprising a powered carriage 57, which runs along an overhead rail 58 having a track 59 for supplying electric current, a track 60 for supplying the control signals emitted by logic unit 55, and a compressed-air supply conduit 61 accessed by each mobile unit 56 at each work station, and supports a substantially L-shaped arm 62 extending downwards from relative carriage 57 and having a substantially horizontal end portion 63 supporting relative drum 17, 20 in rotary manner, and a known actuating device 64 for activating relative drum 17, 20.

Overhead rail 58 of main line 24 extends along an endless path PA comprising a forward work branch 65 extending past work stations 25-27 and 30-32, and a

return branch 66, two points of which are connected to the ends of a shunt 67 having an input station 68 for building drums 17 and extending through tooling station 23.

Similarly, overhead rail 58 of secondary line 34 extends along an endless path PB comprising a forward work branch 69 extending past work stations 37 and 38, and a return branch 70, two points of which are connected to the ends of a shunt 71 having an input station 72 for auxiliary drums 20 and extending through tooling station 33.

Overhead rail 58 of main line 24 comprises a connecting branch 73 forming an extension of forward work branch 65, and which is connected to forward work branch 69 of secondary line 34 and extends through work station 40.

Each of work stations 27, 30-33, 37 and 38 could be provided with one belt conveyor 52. In the example shown, however, each of the above work stations comprises two belt conveyors 52a and 52b, each for supplying one of every two successive drums 17, 20 traveling through the respective work station. In this way, it is possible, during production, to use both belt conveyors 52a and 52b for producing the same type of tire, and, as a tire size and/or type change becomes imminent, stop and recondition for the new production run one of the two belt conveyors, e.g. belt conveyor 52a, at each of the above conventional work stations, transfer the relative mobile building unit

56 to tooling station 23, 33, and complete the ongoing production run using only belt conveyors 52b. Once belt conveyors 52a are reconditioned and the relative mobile building unit 56 retooled, mobile building unit 56 is sent back into circulation along relative path PA, PB to start the new production run, while belt conveyors 52b, once the previous production run is completed, can be stopped and reconditioned, and the relative mobile building units 56 retooled.

In other words, the Figure 8 system provides for making tire size and/or type changes without being shut down completely, and even for producing two different tires simultaneously. The work stations comprising at least one forming machine 41 obviously do not need duplicating, by virtue of forming machines 41 being controlled directly by logic unit 55 via relative logic units 47, and adjusting their operation as each mobile building unit 56 moves past.

The Figure 10 system constitutes a variation of the Figure 8 system, from which it differs by work station 25 being substantially the last, as opposed to the first, along main line 24, and being located along connecting branch 73, immediately downstream from work station 40.

In the Figure 10 system, flat carcass 2a is completed without sidewalls 11, and is shaped to receive tread belt 12 and then tread 15. And only at this point is the almost-finished tire 1 transferred by relative mobile building unit 56 to work station 25, where tire 1

is completed by forming relative sidewalls 11. In this case, as shown in Figure 11, the sidewalls are deposited by forming machines 41, the applicator rollers 46 of which are guided along substantially spiral paths P3.

The location and operation of work station 25 shown in Figures 10 and 11 provide for producing SOT (Side Over Tread) tires, and the Figure 8 system for producing TOS (Tread Over Side) tires.

CLAIMS

1) A tire manufacturing method comprising the steps of forming a flat, substantially cylindrical inner radial carcass (2a) by assembling two metal bead bundles (3) and a number of first components (4-11); shaping said flat inner radial carcass (2a) to form a toroidal carcass (2); and feeding onto said toroidal carcass (2) an annular outer carcass (2') formed by assembling a number of second components (13-16); said components (4-11, 13-16) being assembled on at least one building unit (56), which is moved along a given feed path (PA; PB) extending through a number of work stations (25-32, 35-40), at each of which at least one said component (4-11; 13-16) is fed onto said building unit (56); characterized in that at least one of said work stations (25-32, 35-40) is a programmable work station, at which the relative said component (4-11; 13-16) is formed directly on said building unit (56) by depositing, on said building unit (56), a continuous strip (45) made at least partly of elastomeric material, and which is produced at said programmable work station (25-32; 35-40) and applied to said building unit along a given programmable continuous path (P1; P2; P3), after first being shaped to assume a given substantially constant section.

2) A method as claimed in Claim 1, wherein at least two of said work stations (25-32, 35-40) are programmable work stations comprising respective forming machines (41)

for forming respective said continuous strips (45); said forming machines (41) being substantially identical, and each said forming machine (41) being selectively programmable to impart, by forming, said given section to the relative said continuous strip (45), and to deposit said respective continuous strip (45) on said building unit along a respective said continuous path (P1; P2; P3).

3) A method as claimed in Claim 1 or 2, wherein said continuous path (P1) is substantially helical.

4) A method as claimed in Claim 1 or 2, wherein said continuous path (P2) is substantially sinusoidal.

5) A method as claimed in Claim 1 or 2, wherein said continuous path (P3) is substantially spiral.

6) A method as claimed in one of the foregoing Claims, wherein said first components (4-11) comprise at least a body ply (5); a layer (7) impermeable to air and located on the inside of said body ply (5), between said bead bundles (3); and an annular abrasion strip (10) and an annular sidewall (11), both located outwards of each said bead bundle (3); at least one said first component (4-11) being formed at a respective programmable work station.

7) A method as claimed in Claim 6, wherein said first component (4-11) formed directly on said building unit (56) at said programmable work station (25) is said annular sidewall (11).

8) A method as claimed in Claim 6, wherein said

first component (4-11) formed directly on said building unit (56) at said programmable work station (26) is said annular abrasion strip (10).

9) A method as claimed in Claim 6, wherein said first component (4-11) formed directly on said building unit (56) at said programmable work station (27) is said layer (7) impermeable to air.

10) A method as claimed in Claim 6, wherein said first component (4-11) formed directly on said building unit (56) at said programmable work station (30) is said body ply (5).

11) A method as claimed in one of Claims 1 to 5, wherein said second components (13-16) comprise tread plies (13, 14) at least partly defining a tread belt (12) located on the outside of said toroidal carcass (2); and a tread (15) located on the outside of said tread belt (12); at least one said second component (13-16) being formed at a respective said programmable work station.

12) A method as claimed in Claim 11, wherein said tread plies are formed at the same said programmable work station (37).

13) A method as claimed in Claim 11, wherein said tread belt (12) also comprises a reinforced axial cloth ply (16), which is formed at a respective said programmable work station (38).

14) A method as claimed in Claim 11, wherein said second component (13-16) formed directly on said building unit (56) at said programmable work station (40) is said

tread (15).

15) A method as claimed in one of the foregoing Claims, wherein said building unit (56) comprises a tire building drum (17; 20); a powered support (62) movable along said feed path (PA; PB), said building drum (17; 20) being fitted to said support (62) to rotate about a respective axis; actuating means (64) for rotating said building drum (17; 20) on the relative said support (62); and activating means (58, 59, 60, 61) for activating said building drum (17; 20); said component (4-11; 13-16) being formed by means of said continuous strip (45) of elastomeric material on said building drum (17; 20) by rotating the building drum (17; 20) about its axis on said support (62).

16) A method as claimed in one of the foregoing Claims, wherein said feed path (PA; PB) is a path comprising at least one loop, in turn comprising a forward work portion (65; 69) extending through said work stations (25-32, 35-40), and a return portion (66; 70).

17) A method as claimed in Claim 16, wherein said loop comprises a shunt portion (67; 71) extending between two distinct points of said return portion (66; 70) and through a tooling station (23; 33) for tooling said building unit (56).

18) A method as claimed in any one of the foregoing Claims, wherein said second components (13-16) define a tread belt (12) and a tread (15); the method comprising the steps of feeding said metal bead bundles (3) and said

first components (4-11) onto said building unit (56) to form a complete flat carcass (2a); feeding said tread belt (12) onto the outside of said flat carcass (2a); shaping said flat carcass (2a) inside said tread belt (12); and feeding the tread (15) onto the shaped carcass (2).

19) A method as claimed in any one of Claims 1 to 17, wherein said first components (4-11) comprise two sidewalls (11), and said second components (13-16) define a tread belt (12) and a tread (15); the method comprising the steps of feeding said metal bead bundles (3) and said first components (4-11), with the exception of said sidewalls (11), onto said building unit (56) to form a flat carcass (2a) without said sidewalls (11); feeding said tread belt (12) onto the outside of said flat carcass (2a); shaping said flat carcass (2a) inside said tread belt (12) to obtain said toroidal carcass (2); feeding the tread (15) onto said toroidal carcass (2); and forming said sidewalls (11) directly on said toroidal carcass (2) by depositing a said continuous strip (45) at a relative said programmable work station.

20) A method as claimed in Claim 18 or 19, wherein said feed path (PA; PB) comprises a main loop (24), an auxiliary loop (34), and a connecting portion (73) connecting said loops; and said building units (56) comprise at least one main building unit and one auxiliary building unit; said main loop and said auxiliary loop (24, 34) being traveled by at least one

said main building unit and one said auxiliary building unit respectively; said flat radial carcass (2a) being formed on said main building unit; and said outer carcass (2') being formed on said auxiliary building unit and being transferred onto said main building unit.

21) A method as claimed in Claim 20, wherein said outer carcass (2') is transferred onto said main building unit by a carrier ring (21).

22) A method as claimed in one of the foregoing Claims, wherein at least one said work station (25-32, 35-40) is a conventional work station (25-32, 35-40), wherein the relative said component (4-11; 13-16) is a prefabricated component, which is located at the relative said conventional work station (25-32, 35-40) for supply to said building unit (56) by means of at least one conveying device (52).

23) A method as claimed in Claim 22, wherein said prefabricated component (4-11; 13-16) is stored, at the relative said work station (25-32, 35-40), in a relative interoperational store (53), and is transferred to said building unit (56) by said conveying device (52) connected to said interoperational store (53) by a transfer device (54).

24) A method as claimed in Claim 21 and 22 or 23, wherein each said loop (24, 34) is traveled by at least two relative said building units (56); and wherein each said conventional work station (25-32, 35-40) comprises at least two respective said conveying devices (52a,

52b), each cooperating with a respective said building unit (56); said two conveying devices (52a, 52b) being independent of each other, and supplying components of the same nature but not necessarily identical.

25) A method as claimed in any one of the foregoing Claims, wherein said components (4-11, 13-16) comprise two sidewalls (11), two abrasion strips (10), and a tread (15), which are formed at respective said programmable work stations (25, 26, 40).

26) A method as claimed in one of Claims 22 to 25, wherein said components (4-11, 13-16) comprise a layer (7) impermeable to air; a body ply (5); and a tread belt (12) comprising a reinforced axial cloth ply (16); said layer (7) impermeable to air, said body ply (5), and said reinforced axial cloth ply (16) being formed at respective said conventional work stations (27, 30, 38).

27) A method as claimed in any one of the foregoing Claims, wherein each said programmable work station is controlled by a user-interface logic unit (55), which provides for loading a first number (55a) of data items (inside radius, sidewall height, tread width, etc.) relative to the size of a tire (1) to be produced, and a second number (55b) of data items relative to the tire model to be produced.

28) A method as claimed in Claims 2 and 27, wherein said continuous strip (45) is deposited on said building unit (56) by said forming machine (41) by means of an applicator roller (46), which is movable in space under

the control of a guiding logic unit (47) containing programs to follow a said programmable path (P1; P2; P3); a given said program being selected by said user-interface logic unit (55).

29) A method as claimed in Claims 23 and 27, wherein each said conventional work station is controlled by said user-interface logic unit (55) by means of the relative said transfer device (54); said user-interface logic unit (55) memorizing the distribution of the various sizes and various types of the relative prefabricated component in the relative said interoperational store (53).

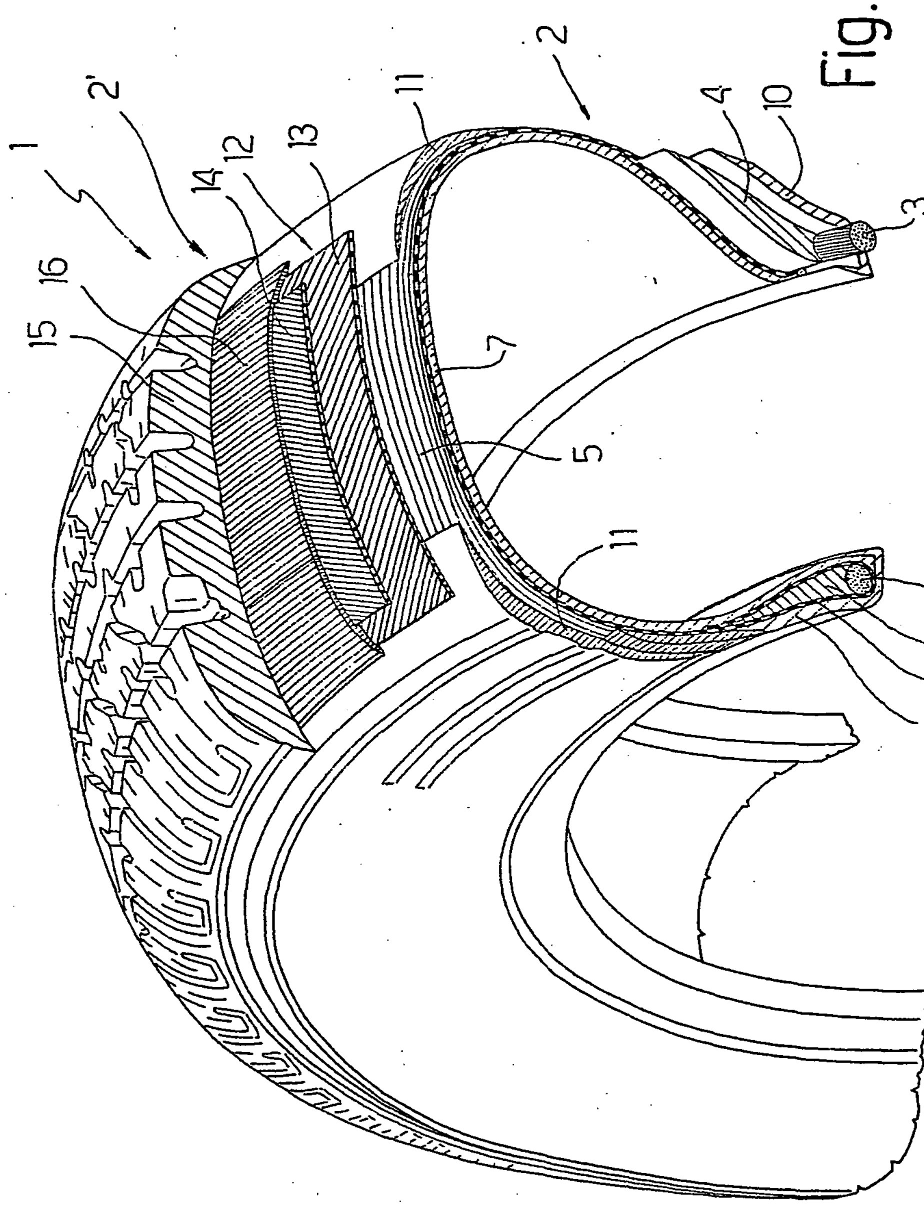
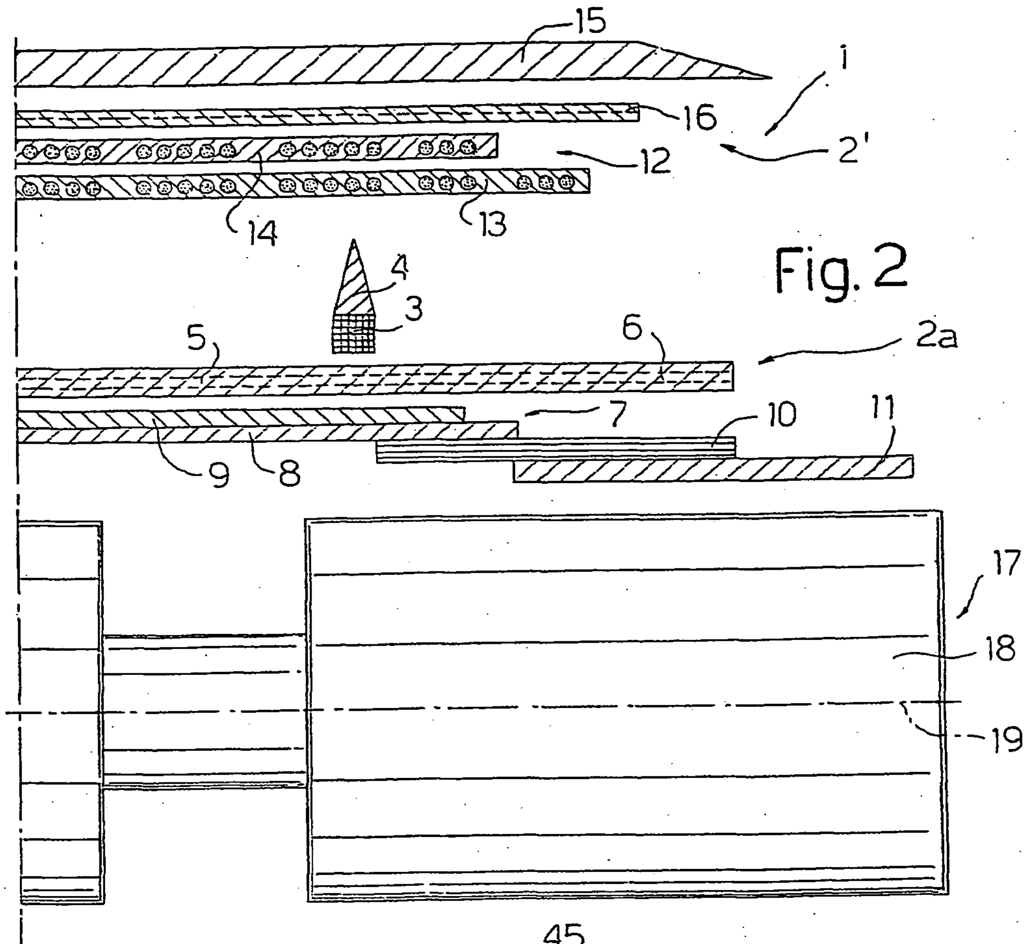


Fig.1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2'
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2a
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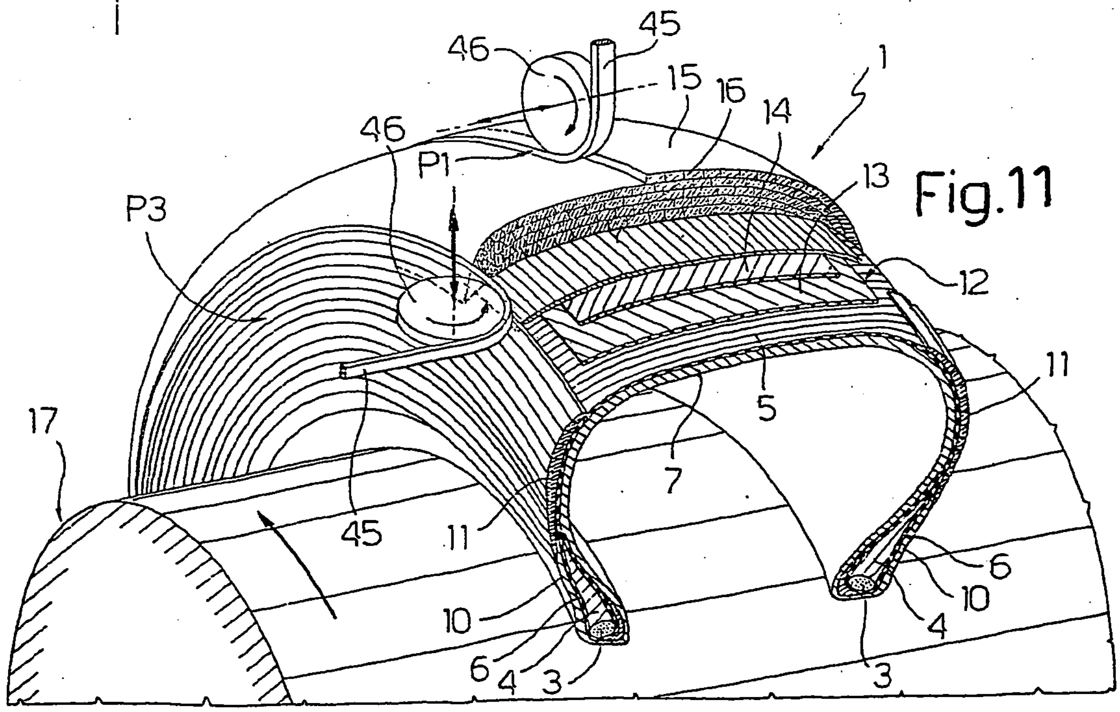
Fig. 2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P1
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P3
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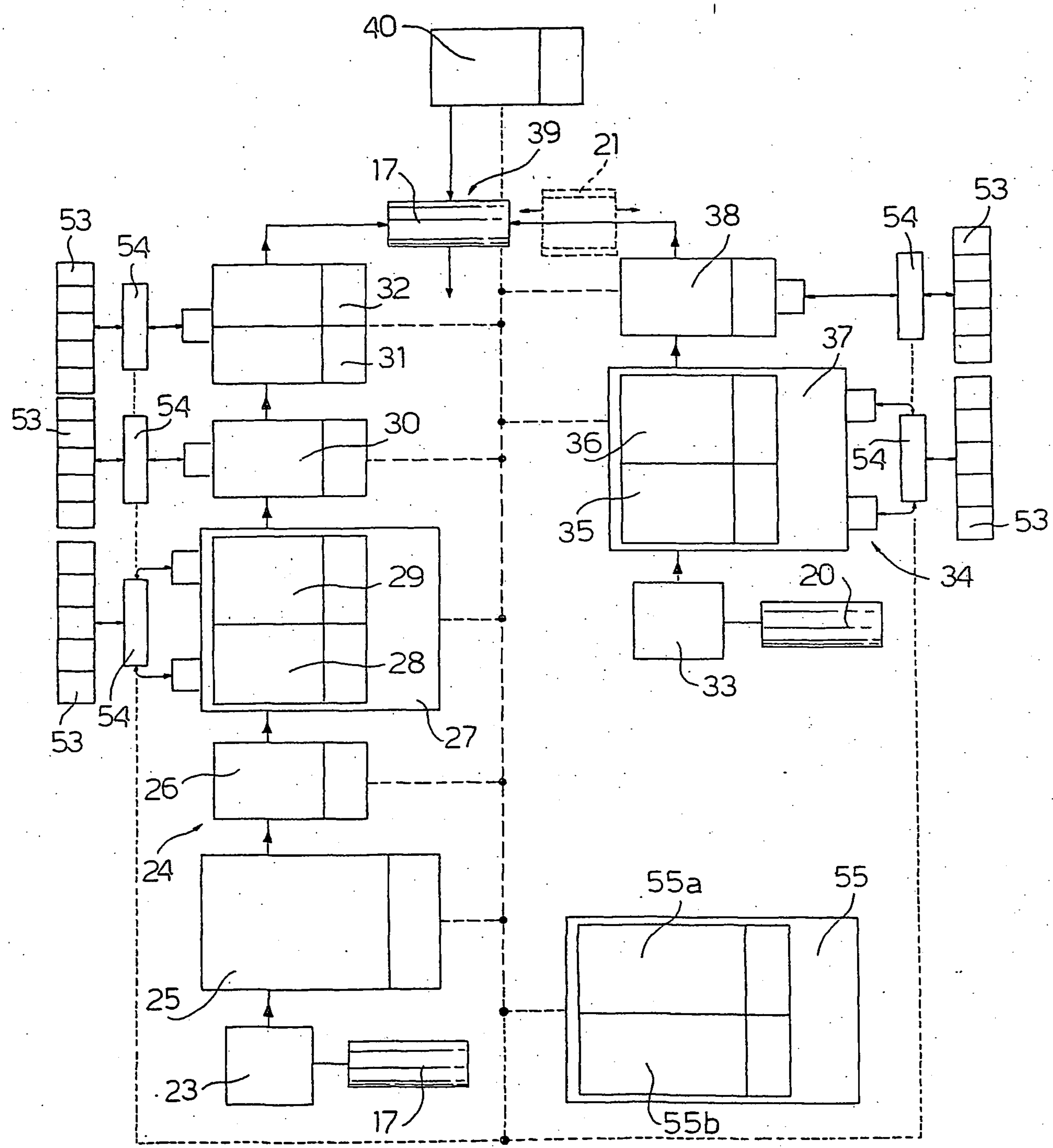
Fig.11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55a
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25
23
17
55b

Fig.3

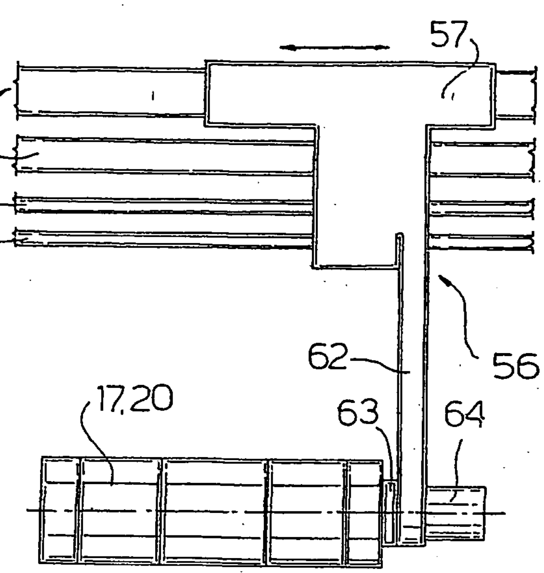


Fig.9

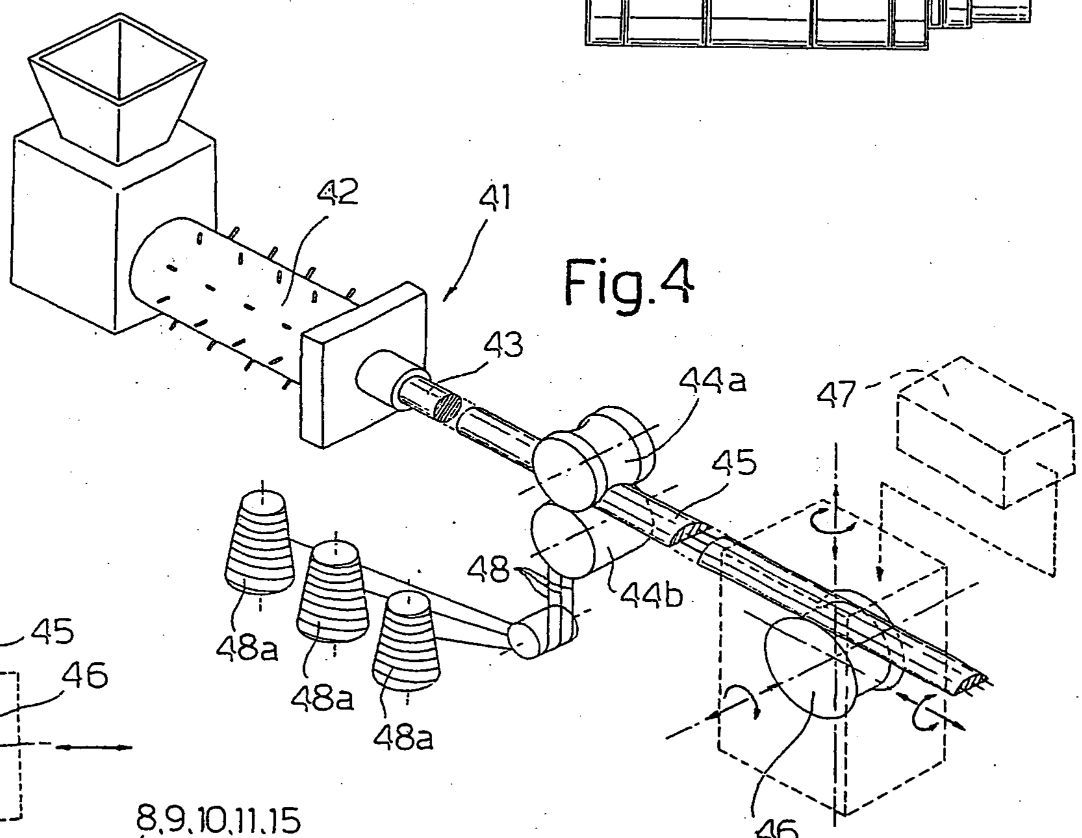


Fig.4

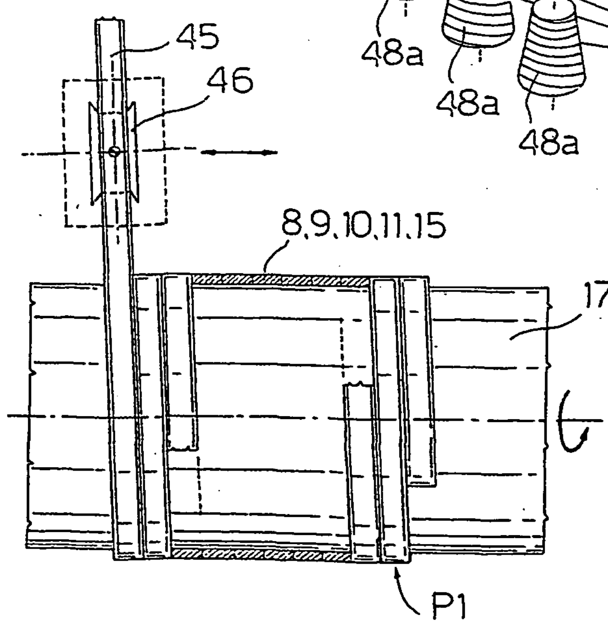


Fig.5

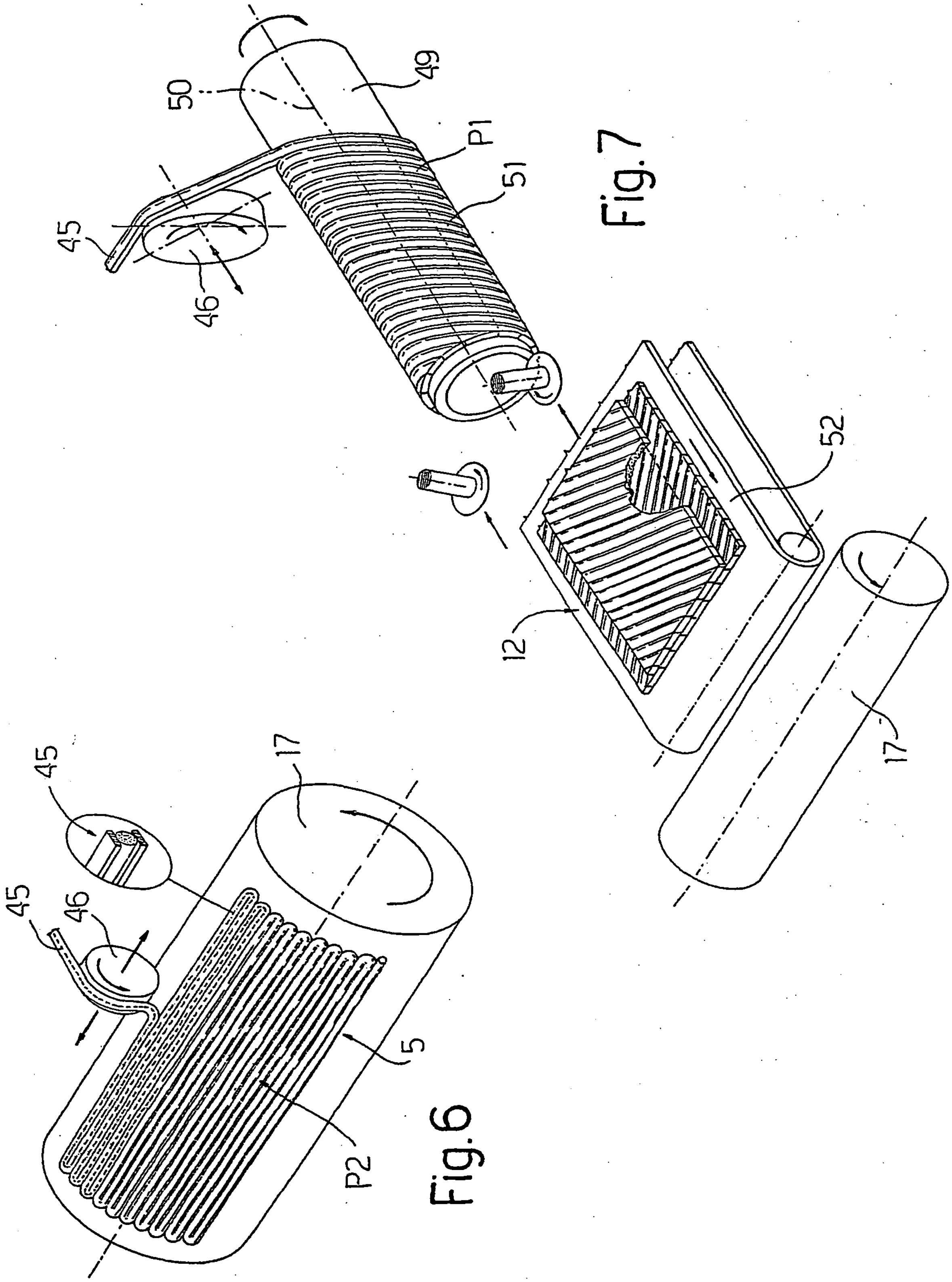
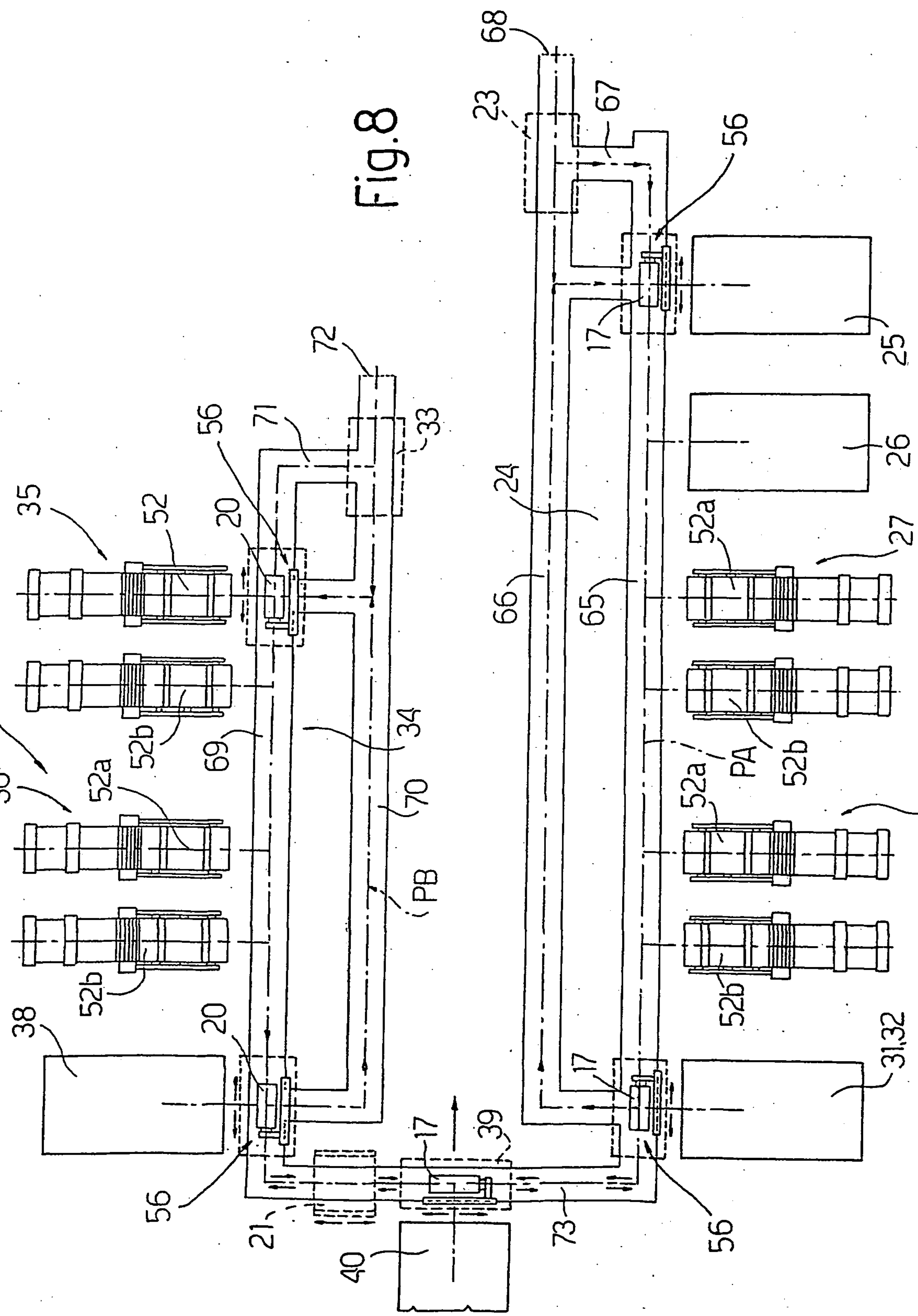


Fig.7

Fig.6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37
52b
34
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PA
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52a
70
30
PB
52b
38
20
31,32
17
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56
21
73
40

Fig.8

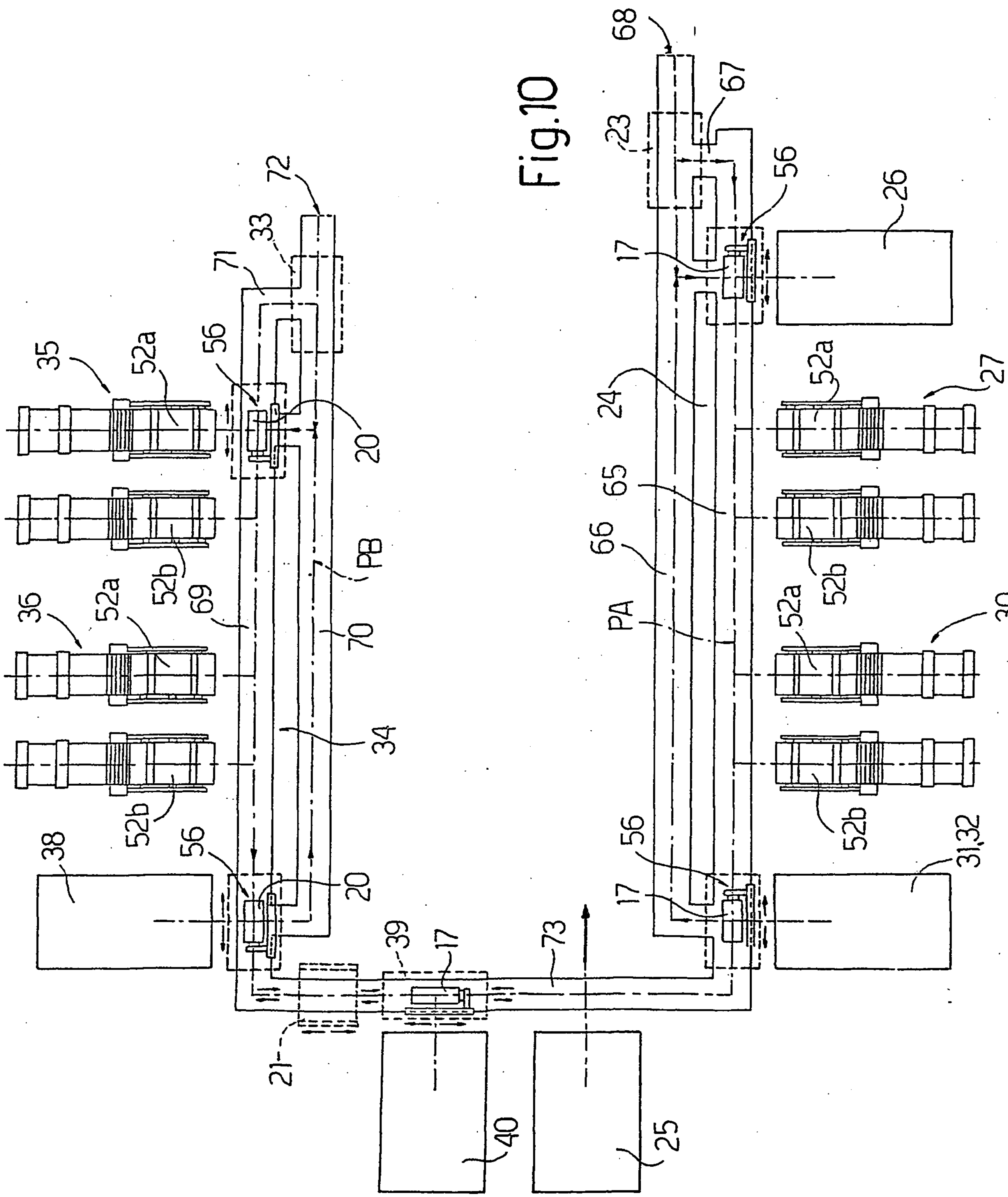

Fig.10

INTERNATIONAL SEARCH REPORT

International Application No
PCT/IT 02/00328

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B29D30/00 B29D30/20

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B29D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 875 364 A (PIRELLI) 4 November 1998 (1998-11-04) column 9, line 25 -column 13, line 38; figure 2 column 9, line 43 - line 45 column 11, line 50 -column 12, line 4 column 12, line 13 - line 33 column 20, line 48 -column 21, line 26 ---	1,2, 6-16, 21-23
X	US 3 775 220 A (RATTRAY W) 27 November 1973 (1973-11-27) the whole document --- -/--	1,2,6,7, 11,12, 15,16, 22,27

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
27 August 2002	04/09/2002

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Fregosi, A

INTERNATIONAL SEARCH REPORT

International Application No
PCT/IT 02/00328

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 732 640 A (GOODFELLOW ANTHONY G) 22 March 1988 (1988-03-22) column 1, line 51 -column 2, line 8; figure 1 column 3, line 1 - line 7	1,3,6,9, 11,15, 16,18, 22-24,26
A	WO 01 32409 A (PIRELLI ;CARETTA RENATO (IT); MARIANI FIORENZO (IT)) 10 May 2001 (2001-05-10) the whole document	1-3, 5-16, 27-29
A	WO 00 35666 A (MARCHINI MAURIZIO ;SCARZELLO OSVALDO (IT); PIRELLI (IT); CARETTA R) 22 June 2000 (2000-06-22) page 3, line 4 - line 7 page 6, line 3 - line 9 page 8, line 33 -page 10, line 9; figure 1 page 16, line 1 - line 19	1-3, 6-12,14, 22-28
A	US 4 443 290 A (JOHNSEN JOHN A ET AL) 17 April 1984 (1984-04-17) the whole document	1,2,6-16
A	US 4 877 468 A (SIEGENTHALER KARL J) 31 October 1989 (1989-10-31) the whole document	1-29
A	EP 0 448 407 A (BRIDGESTONE CORP) 25 September 1991 (1991-09-25) the whole document	1-29
A	US 4 565 514 A (MARANGONI CARLO) 21 January 1986 (1986-01-21) cited in the application the whole document	1,2,13
A	EP 0 537 780 A (CONTINENTAL AG) 21 April 1993 (1993-04-21) the whole document	1-3
A	US 3 751 316 A (MENOUGH R ET AL) 7 August 1973 (1973-08-07) the whole document	1-3,5, 11,12
A	US 3 770 042 A (GREENE C ET AL) 6 November 1973 (1973-11-06) the whole document	1,2,4, 11,12

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/IT 02/00328

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
EP 0875364	A	04-11-1998	EP	0875364	A2	04-11-1998
			BR	9801526	A	27-04-1999
			CN	1198379	A	11-11-1998
			JP	11042651	A	16-02-1999
			TR	9800763	A1	23-11-1998
US 3775220	A	27-11-1973	NONE			
US 4732640	A	22-03-1988	AU	577585	B2	29-09-1988
			AU	4189985	A	14-11-1985
			BR	8502173	A	07-01-1986
			DE	3576472	D1	19-04-1990
			EP	0167224	A2	08-01-1986
			GB	2158400	A ,B	13-11-1985
			JP	4014621	B	13-03-1992
			JP	60245542	A	05-12-1985
			ZA	8503084	A	26-02-1986
WO 0132409	A	10-05-2001	AU	1515001	A	14-05-2001
			BR	0015118	A	25-06-2002
			WO	0132409	A1	10-05-2001
			EP	1224074	A1	24-07-2002
WO 0035666	A	22-06-2000	BR	9916360	A	18-09-2001
			CN	1333716	T	30-01-2002
			EP	1150829	A1	07-11-2001
			WO	0035666	A1	22-06-2000
			TR	200101726	T2	21-12-2001
			TW	464607	B	21-11-2001
			US	2001042586	A1	22-11-2001
US 4443290	A	17-04-1984	CA	1187774	A1	28-05-1985
			DE	3272565	D1	18-09-1986
			EP	0105048	A1	11-04-1984
			JP	1463109	C	28-10-1988
			JP	58217239	A	17-12-1983
			JP	63011140	B	11-03-1988
			KR	8900879	B1	12-04-1989
US 4877468	A	31-10-1989	IT	1189672	B	04-02-1988
			AT	75185	T	15-05-1992
			AU	600487	B2	16-08-1990
			AU	7314787	A	26-11-1987
			BR	8702543	A	23-02-1988
			CA	1284859	A1	18-06-1991
			CN	87103671	A ,B	02-03-1988
			CS	8703662	A2	12-07-1990
			DD	261758	A5	09-11-1988
			DE	3778418	D1	27-05-1992
			EP	0246498	A2	25-11-1987
			ES	2031465	T3	16-12-1992
			JP	2544384	B2	16-10-1996
			JP	62290508	A	17-12-1987
			KR	9510645	B1	21-09-1995
			MX	170667	B	06-09-1993
			PT	84892	A ,B	01-06-1987
			ZA	8703636	A	17-11-1987

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/IT 02/00328

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
EP 0448407	A	25-09-1991	JP	3270835 A	03-12-1991
			EP	0448407 A2	25-09-1991
US 4565514	A	21-01-1986	IT	1181389 B	23-09-1987
EP 0537780	A	21-04-1993	DE	4134323 A1	22-04-1993
			EP	0537780 A2	21-04-1993
			JP	5309761 A	22-11-1993
US 3751316	A	07-08-1973	US	3837387 A	24-09-1974
US 3770042	A	06-11-1973	AT	314377 B	15-02-1974
			AU	3300271 A	08-03-1973
			BE	772154 A1	17-01-1972
			CA	935748 A1	23-10-1973
			CH	544667 A	30-11-1973
			DE	2144057 A1	21-09-1972
			ES	200814 Y	16-02-1976
			FR	2105212 A1	28-04-1972
			GB	1361998 A	30-07-1974
			JP	52008869 B	11-03-1977
			LU	63839 A1	27-06-1972
			NL	7112174 A ,B	07-03-1972
			SE	383618 B	22-03-1976
			US	3720569 A	13-03-1973
			US	3720570 A	13-03-1973
			US	3729365 A	24-04-1973
			ZA	7105664 A	26-07-1972
			CA	935750 A1	23-10-1973
			CA	935749 A1	23-10-1973